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Multi-angular observations of vegetation indices from UAV cameras

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Abstract

Unmanned aerial vehicles (UAVs) are found as an alternative to the classical manned aerial photogrammetry, which can be used to obtain environmental data or as a complementary solution to other methods (Nex and Remondino, 2014). Although UAVs have coverage limitations, they have better resolution compared to satellites and aircrafts, they are cheaper and easy to handle, providing data in a short period of time (Matese *et al.*, 2015; Uysal, Toprak and Polat, 2015). Furthermore, they can be equipped with different types of payloads carrying various sensors such as a thermal and multispectral cameras (Berni *et al.*, 2009), hyper spectral camera (Burkart *et al.*, 2015) and photometric elevation mapping sensor (Shahbazi *et al.*, 2015) among others. Therefore, UAVs can be used in many fields such as agriculture, forestry, archeology, architecture, environment and traffic monitoring (Nex and Remondino, 2014).

In this study, the UAV used is a hexacopter s900 equipped with a Global Positioning System (GPS) and two cameras; a digital RGB photo camera and a multispectral camera (MCA), with a resolution of 5472 x 3648 pixels and 1280 x 1024 pixels, respectively. In terms of applications, traditional methods using vegetation indices from reflectance often assume Lambertian models (de Moura *et al.*, 2015), where the light is reflected equally in all the directions (Mobley, 2014) and, therefore, multi-angular reflectance is not considered. However, differences in directional scattering (anisotropy) can provide important data about biophysical behavior in vegetation such as leaf area index (LAI), leaf angular distribution (LAD), vegetation water content, nitrogen and chlorophyll content (Tagesson *et al.*, 2015), canopy roughness and others (de Moura *et al.*, 2015). The Bidirectional Reflectance Distribution Function (BRDF) describes the surface reflectance changes depending on viewing geometry, usually used to analyze remote sensing data from satellite, airborne and surface platforms. (Singh *et al.*, 2016). BRDF observations can also be obtained with the MCA camera located in the UAV. Thus, the aim of this study is to capture multi-angular observations in different forest locations (Sorø and Risø) in Denmark by flying the UAV over the area of interest. Since the payload has a fix position, the viewing angles obtained due to the Field of view (FOV) of the MCA camera can be exploited and the flight pattern simulates some goniometer positions. This approach allows to measure different azimuth and zenith angles according to the sun position and to acquire different characteristics of vegetation depending on a specific time and amount of light.

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